

How the Human Genome Project Is Reshaping Science and Health

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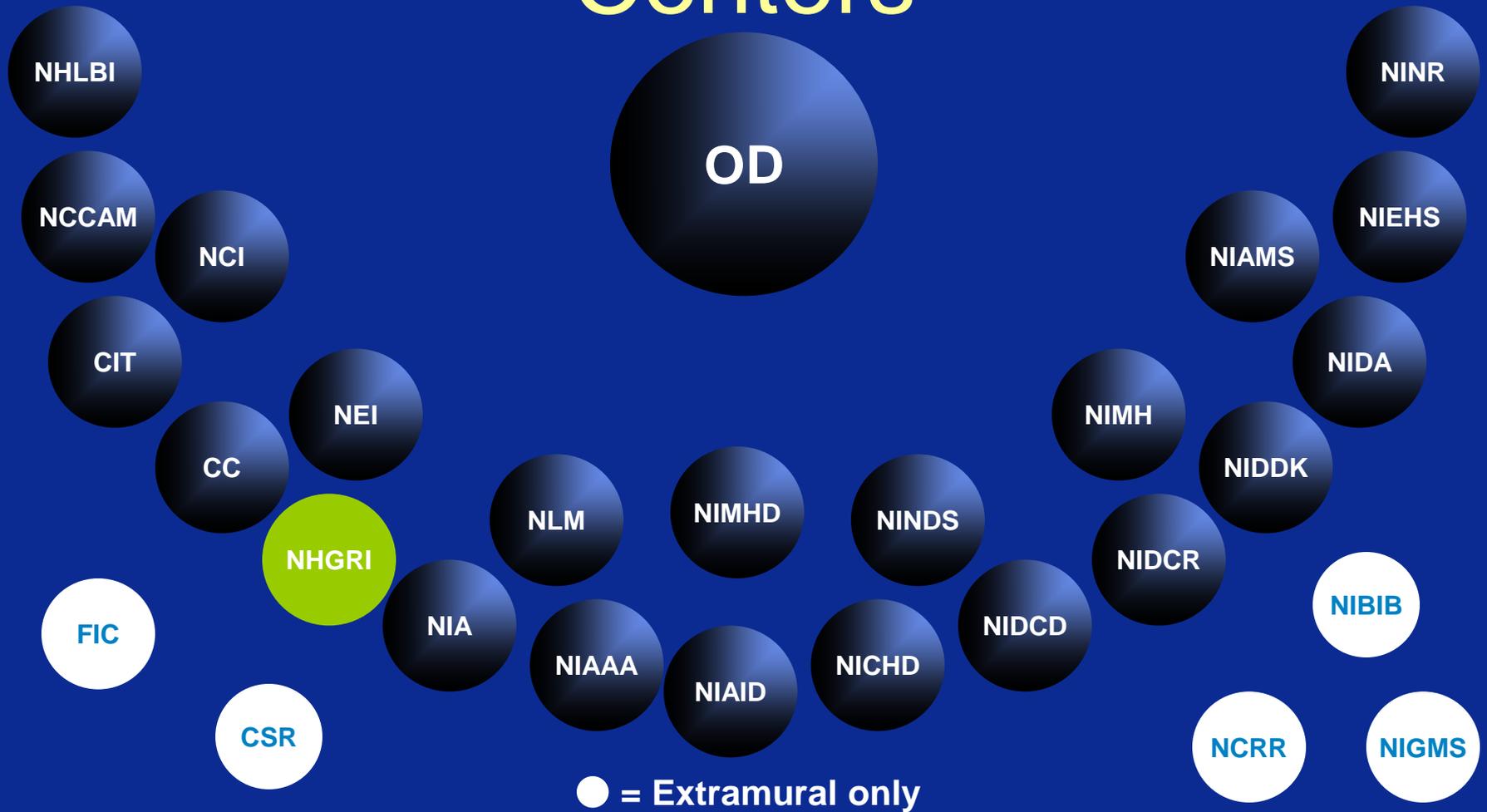


Overview

- History of HGP—the Past
- Genomics in the Present
- Genomics in the Future



NIH consists of 27 Institutes and Centers



National Human Genome Research Institute (NHGRI)

- Led the NIH's contribution to the Human Genome Project
- Mission involves studies to understand structure and function of genome
- Studies role of genome on human health

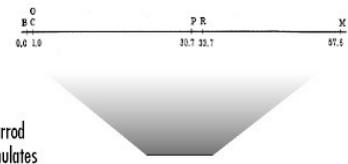




Mendel discovers laws of genetics
1865



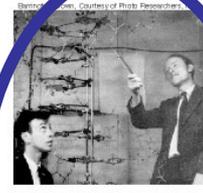
Rediscovery of Mendel's work
1900



Garrod formulates the concept of human inborn errors of metabolism
1905

Sturtevant makes the first linear map of genes
1913

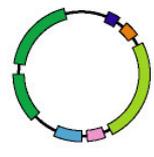
Avery, McCleod, and McCarty demonstrate DNA is the hereditary material
1944



Watson and Crick describe the double helical structure of DNA
1953

	U	C	A	G
Phe	Leu	Ser	Tyr	Cys
Leu	Pro	His	Arg	
Met	Thr	Asn	Ser	
Val	Ala	Asp	Gly	
				U
				C
				A
				G

Monod, Jacob, and Parodi determine the genetic code
1966



Cohen and Boyer develop recombinant DNA technology
1972

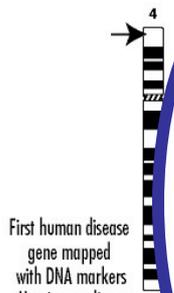
Issuing of Belmont Report on the use of human subjects in research
1974



Sanger and Maxam & Gilbert develop DNA sequencing methods
1977

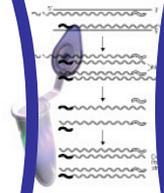


GenBank database established
1982



First human disease gene mapped with DNA markers - Huntington disease
1983

First public discussion of sequencing the human genome
1984



Muscular dystrophy gene identified by positional cloning

First automated DNA sequencing instrument developed
1986

PCR invented
1985

International Nucleotide Sequence Database Consortium formed

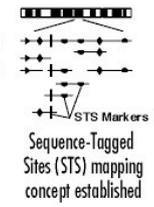


First-generation human genetic map developed
1987

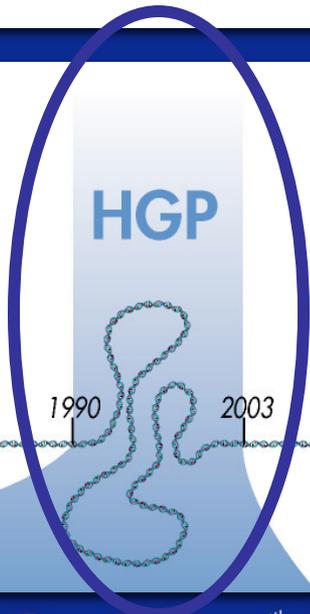
National Research Council (U.S.) issues report on Mapping and Sequencing the Human Genome

Development of yeast artificial chromosome (YAC) cloning

Human Genome Organization (HUGO) formed
1988



Cystic fibrosis gene identified by positional cloning
1989



1990

2003





The Human Genome Project

- An international government project that ended ahead of schedule!
- And under budget!!
- And from its start earmarked funds for consideration of its ethical, legal, and social implications (ELSI) - the greatest funding ever devoted to bioethics



The Human Genome Project

- Produced the human genome sequence
- Spurred new technologies
- Helped spawn a new field: genomics
- And now provides new knowledge, technologies, and approaches for understanding health and changing health care



HGP Fun Fact: Number of Human Genes – Some Context...

- How many genes do we humans have?



HGP Fun Fact: Number of Genes - How Do We Humans Measure Up?

- H. flu 1,700
- E. coli 4,300
- Fruit fly 13,600
- Worm 18,400
- Cow ~22,000
- Arabidopsis (thale cress) 25,500



HGP Fun Fact: Number of Genes - How Do We Humans Measure Up?

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- **You** ~**20,500**
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WHAT IS A GENE?

The idea of genes as beads on a DNA string is fast fading. Protein-coding sequences have no clear beginning or end and RNA is a key part of the information package, reports **Helen Pearson**.

'Gene' is not a typical four-letter word. It is not offensive. It is never bleeped out of TV shows. And where the meaning of most four-letter words is all too clear, that of gene is not. The more expert scientists become in molecular genetics, the less easy it is to be sure about what, if anything, a gene actually is.

Rick Young, a geneticist at the Whitehead Institute in Cambridge, Massachusetts, says that when he first started teaching as a young professor two decades ago, it took him about two hours to teach fresh-faced undergraduates what a gene was and the nuts and bolts of how it worked. Today, he and his colleagues need three months of lectures to convey the concept of the gene, and that's not because the students are any less bright. "It takes a whole semester to teach this stuff to talented graduates," Young says. "It used to be we could give a one-off definition and now it's much more complicated."

In classical genetics, a gene was an abstract concept — a unit of inheritance that ferried a characteristic from parent to child. As biochemistry came into its own, those characteristics were associated with enzymes or proteins, one for each gene. And with the advent of mol-

Laurence Hurst at the University of Bath, UK.

"All of that information seriously challenges our conventional definition of a gene," says molecular biologist Bing Ren at the University of California, San Diego. And the information challenge is about to get even tougher. Later this year, a glut of data will be released from the international Encyclopedia of DNA Elements (ENCODE) project. The pilot phase of ENCODE involves scrutinizing roughly 1% of the human genome in unprecedented detail; the aim is to find all the sequences that serve a useful purpose and explain what that purpose is. "When we started the ENCODE project I had a different view of what a gene was," says contributing researcher Roderic Guigo at the Center for Genomic Regulation in Barcelona. "The degree of complexity we've seen was not anticipated."

Under fire

The first of the complexities to challenge molecular biology's paradigm of a single DNA sequence encoding a single protein was alterna-

tively unimagined scope of RNA.

The one gene, one protein idea is coming under particular assault from researchers who are comprehensively extracting and analysing the RNA messages, or transcripts, manufactured by genomes, including the human and mouse genome. Researchers led by Thomas Gingeras at the company Affymetrix in Santa Clara, California, for example, recently studied all the transcripts from ten chromosomes across eight human cell lines and worked out

precisely where on the chromosomes each of the transcripts came from³.

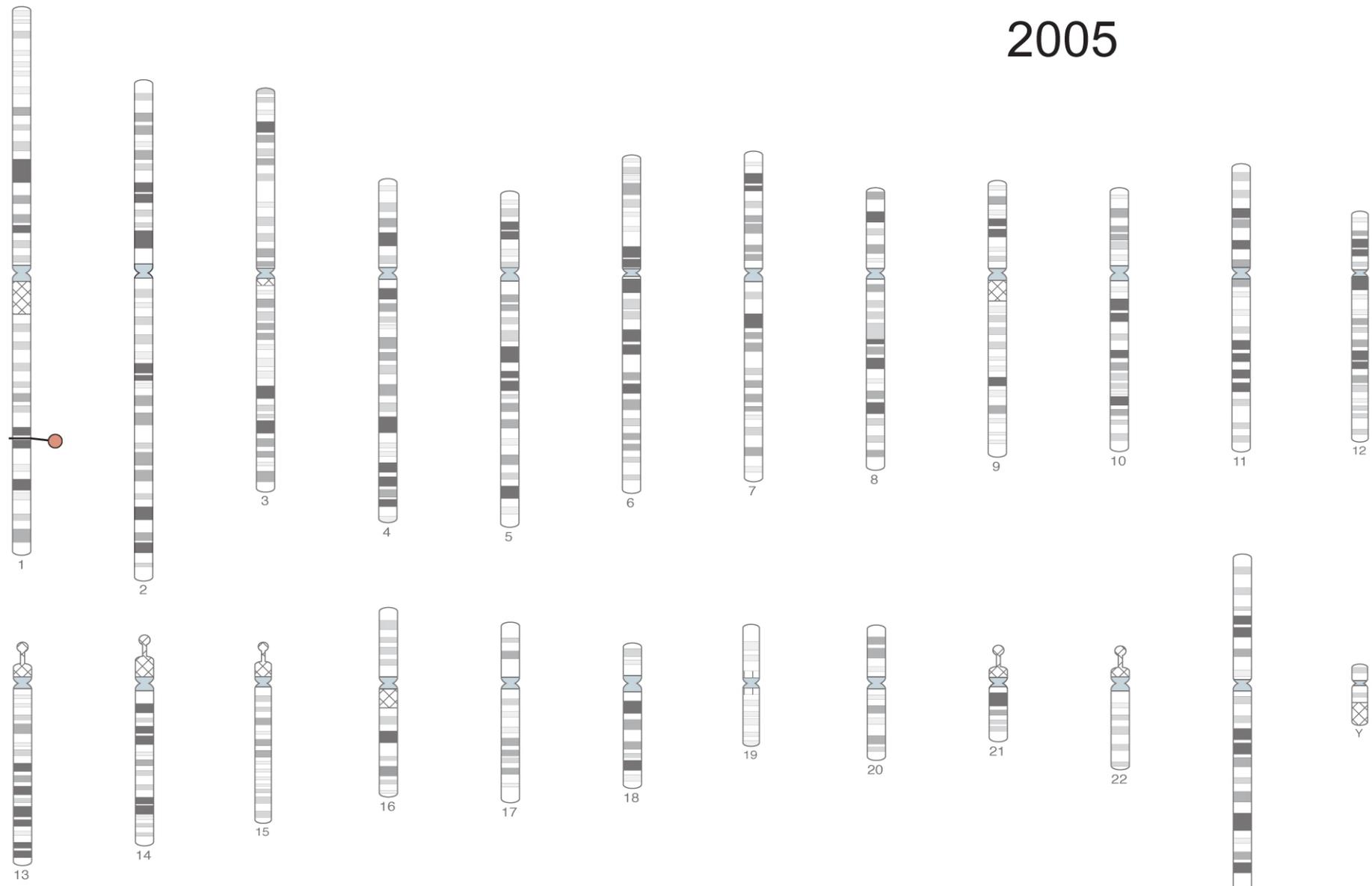
The picture these studies paint is one of mind-boggling complexity. Instead of discrete genes dutifully mass-producing identical RNA transcripts, a teeming mass of transcription converts many segments of the genome into multiple RNA ribbons of differing lengths. These ribbons can be generated from both strands of DNA, rather than from just one as was conventionally thought. Some of these transcripts come from regions of DNA previously identified as holding protein-coding

"We've come to the realization that the genome is full of overlapping transcripts."

— Phillip Kapranov

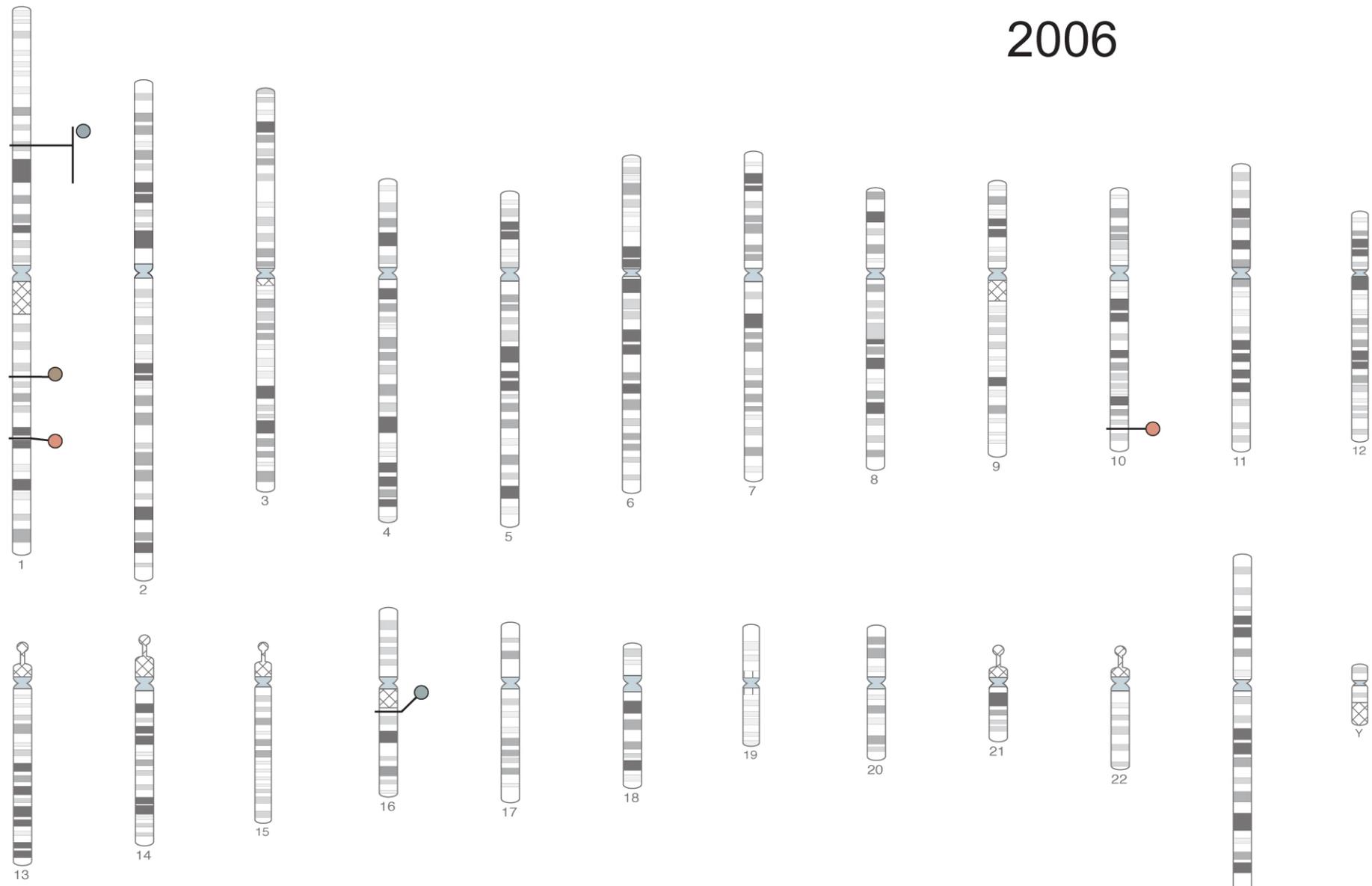


2005



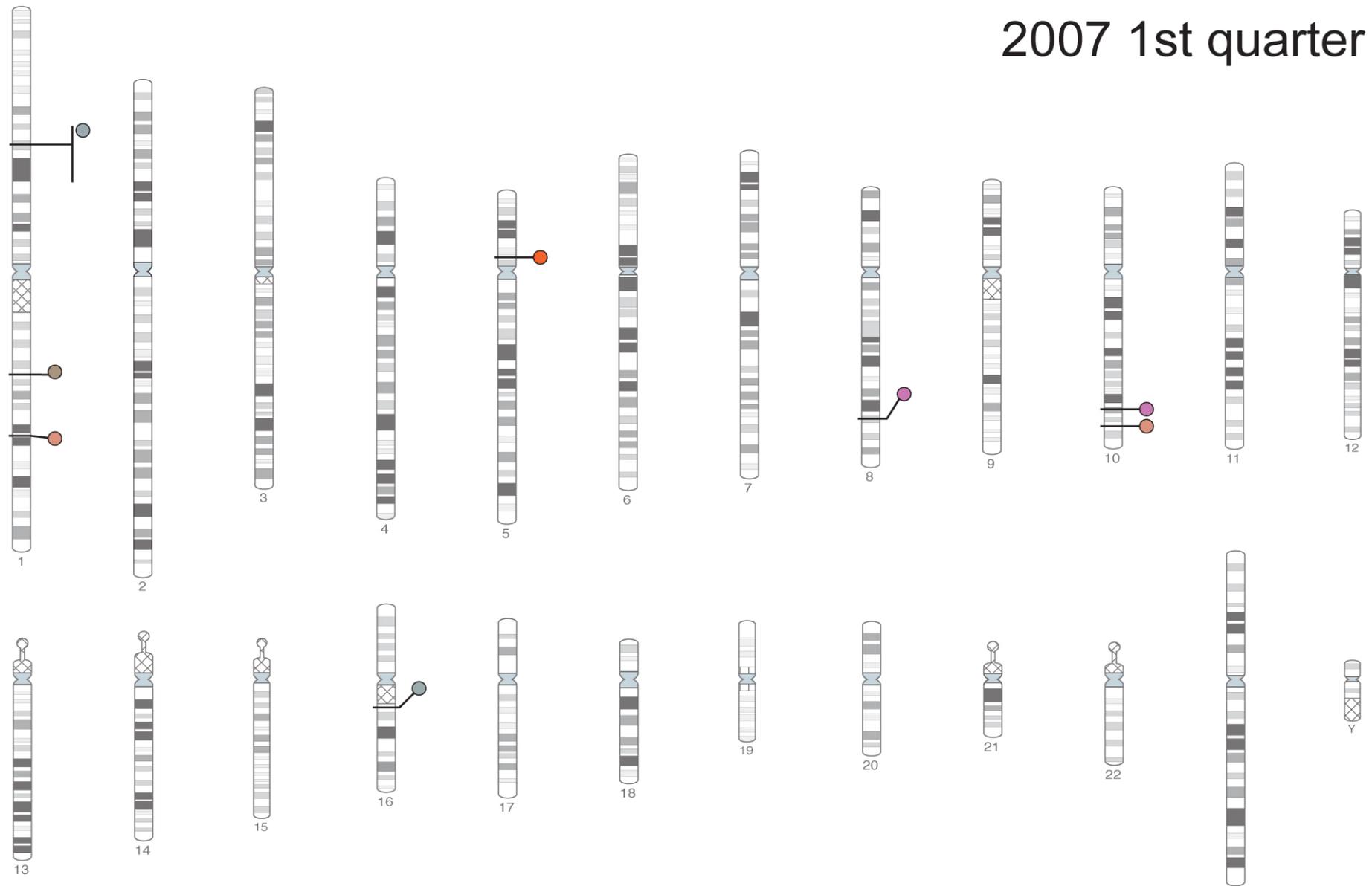
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2006



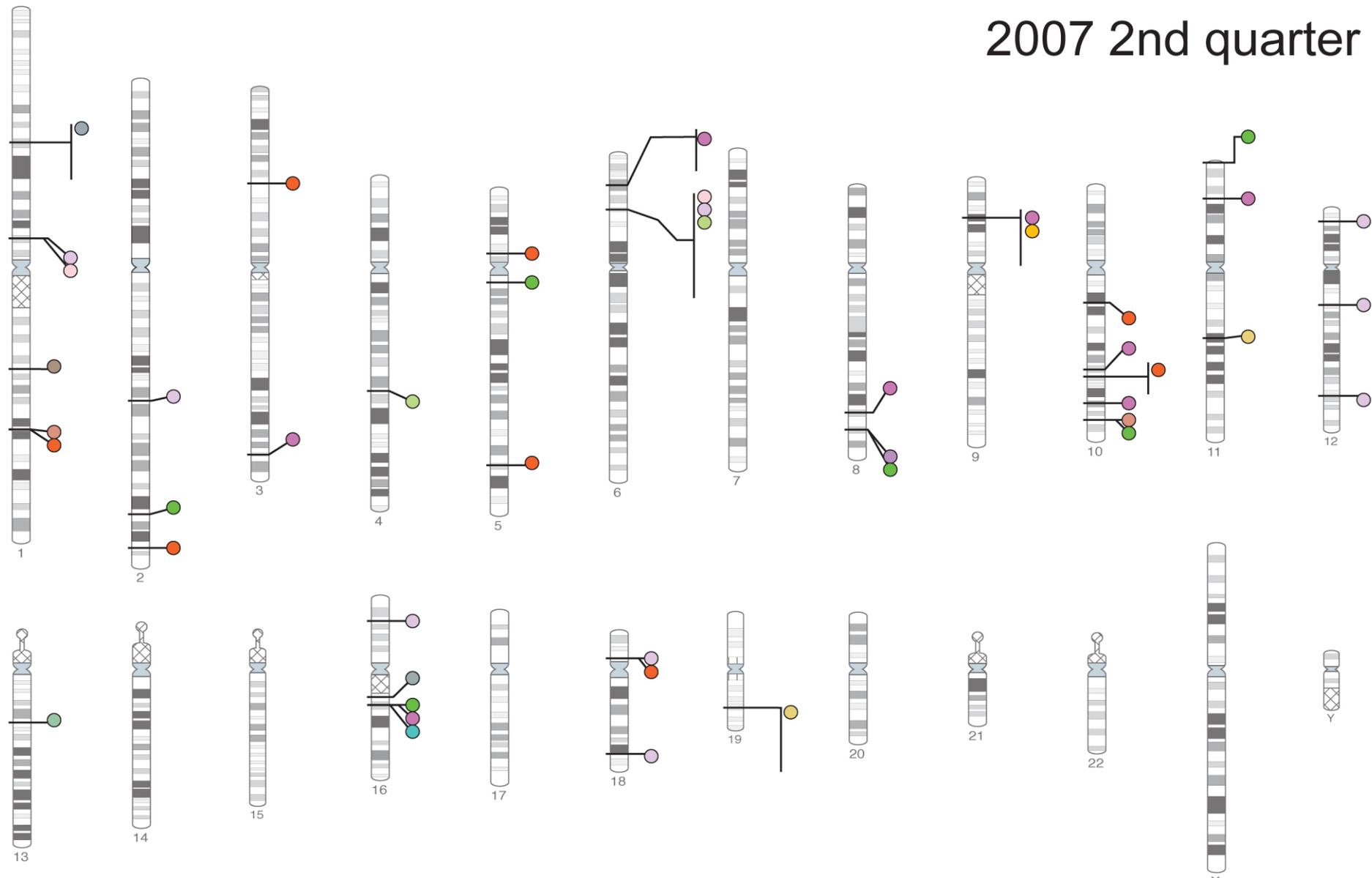
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2007 1st quarter



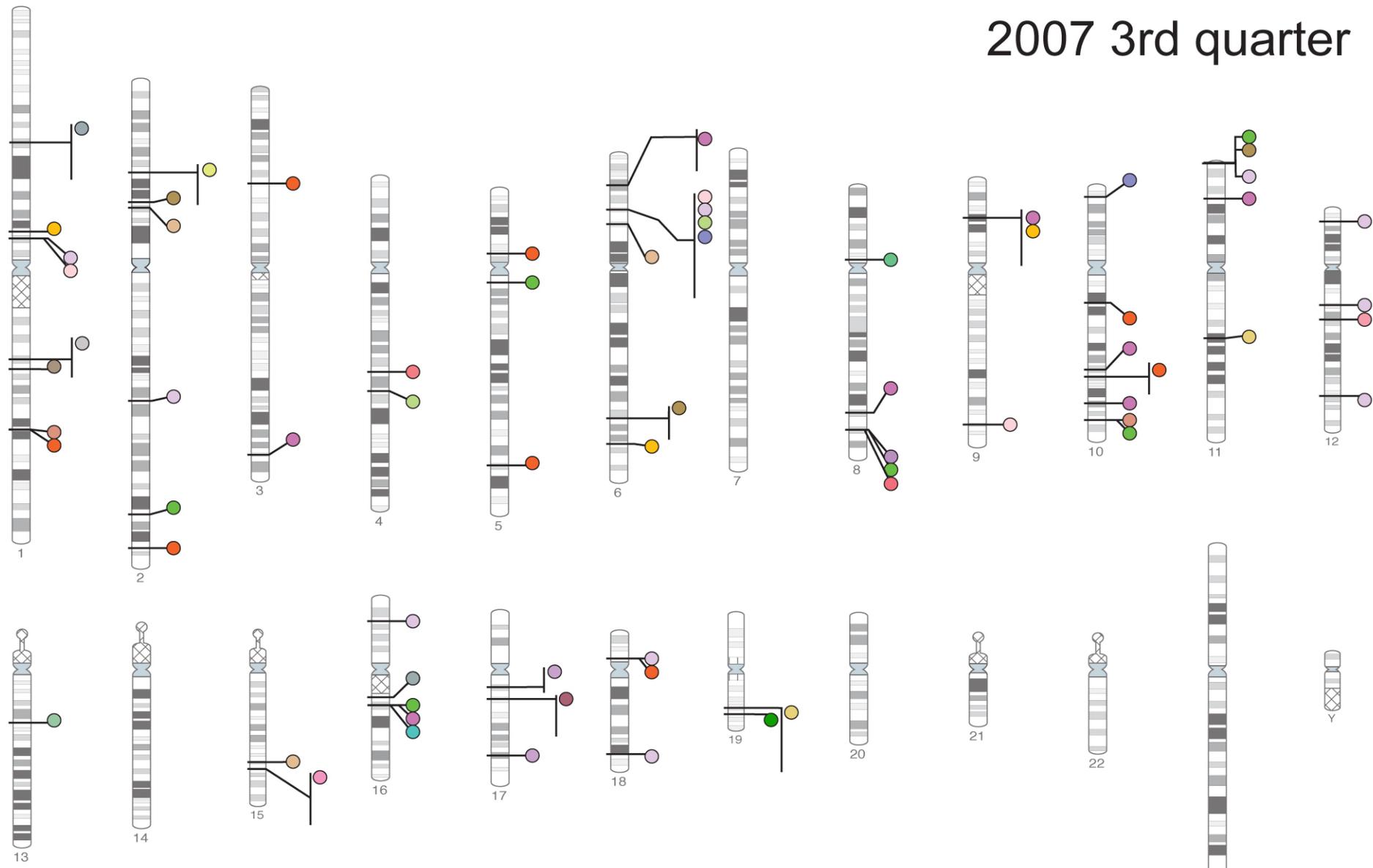
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2007 2nd quarter



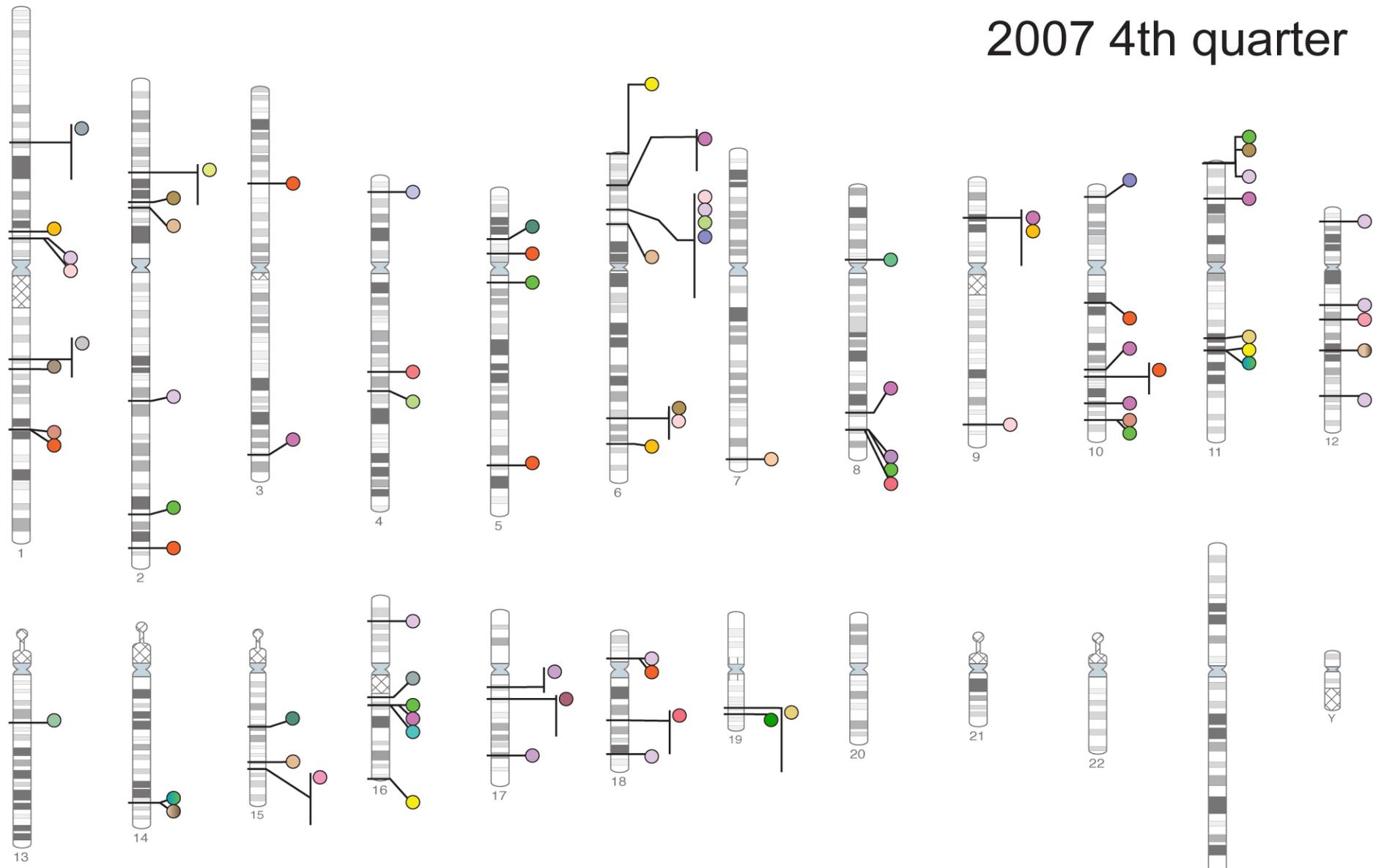
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2007 3rd quarter



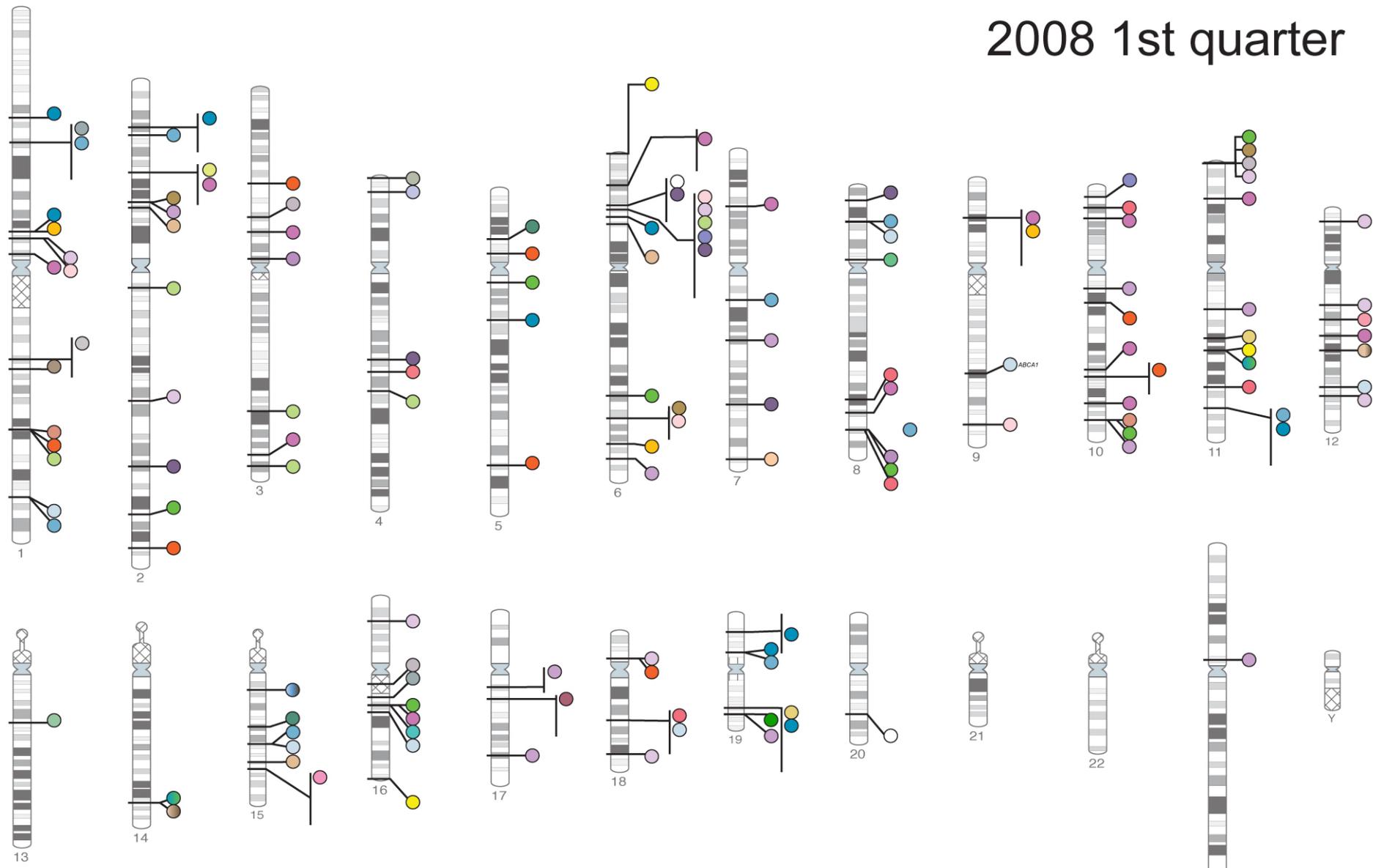
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2007 4th quarter



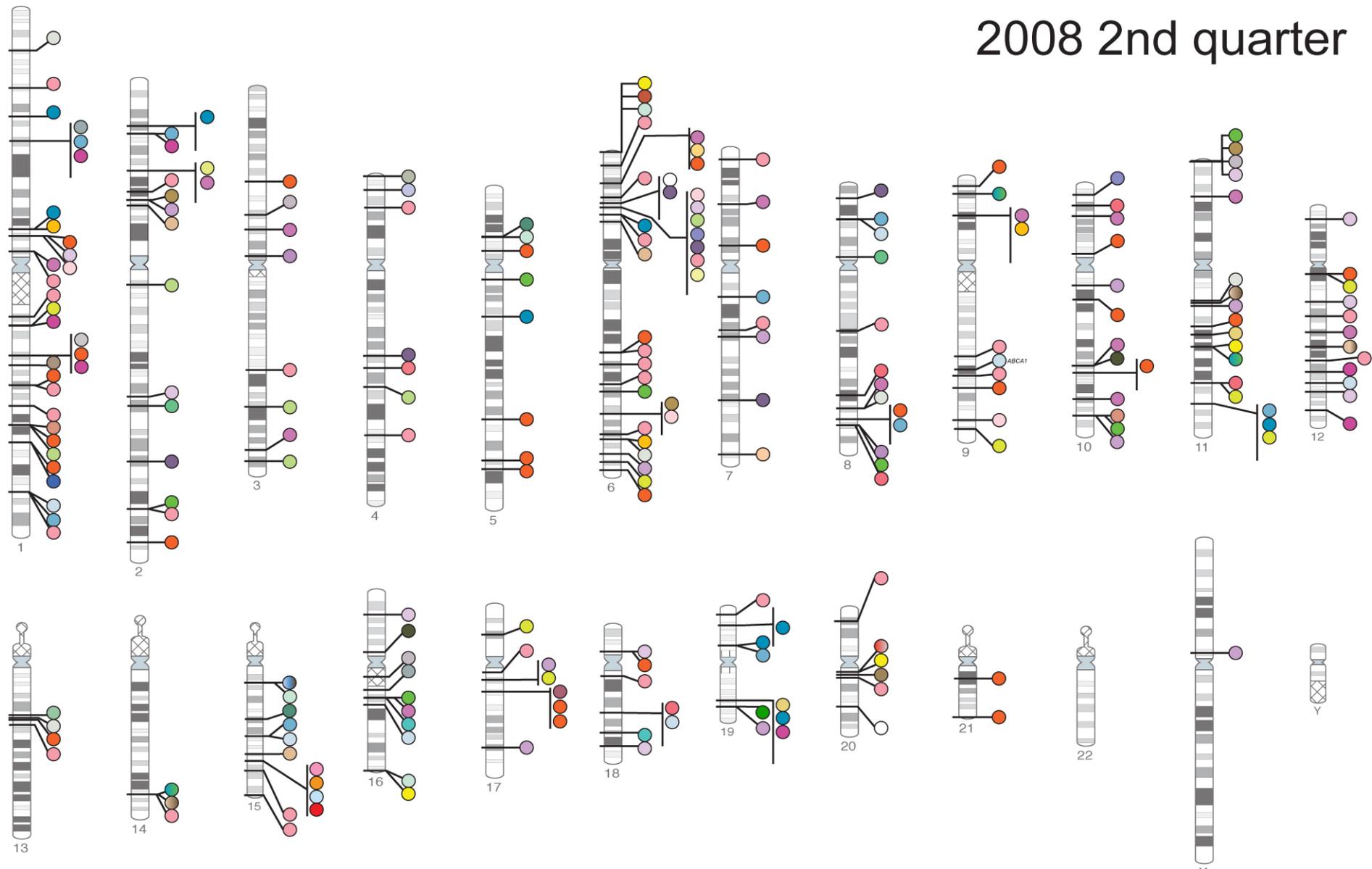
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2008 1st quarter



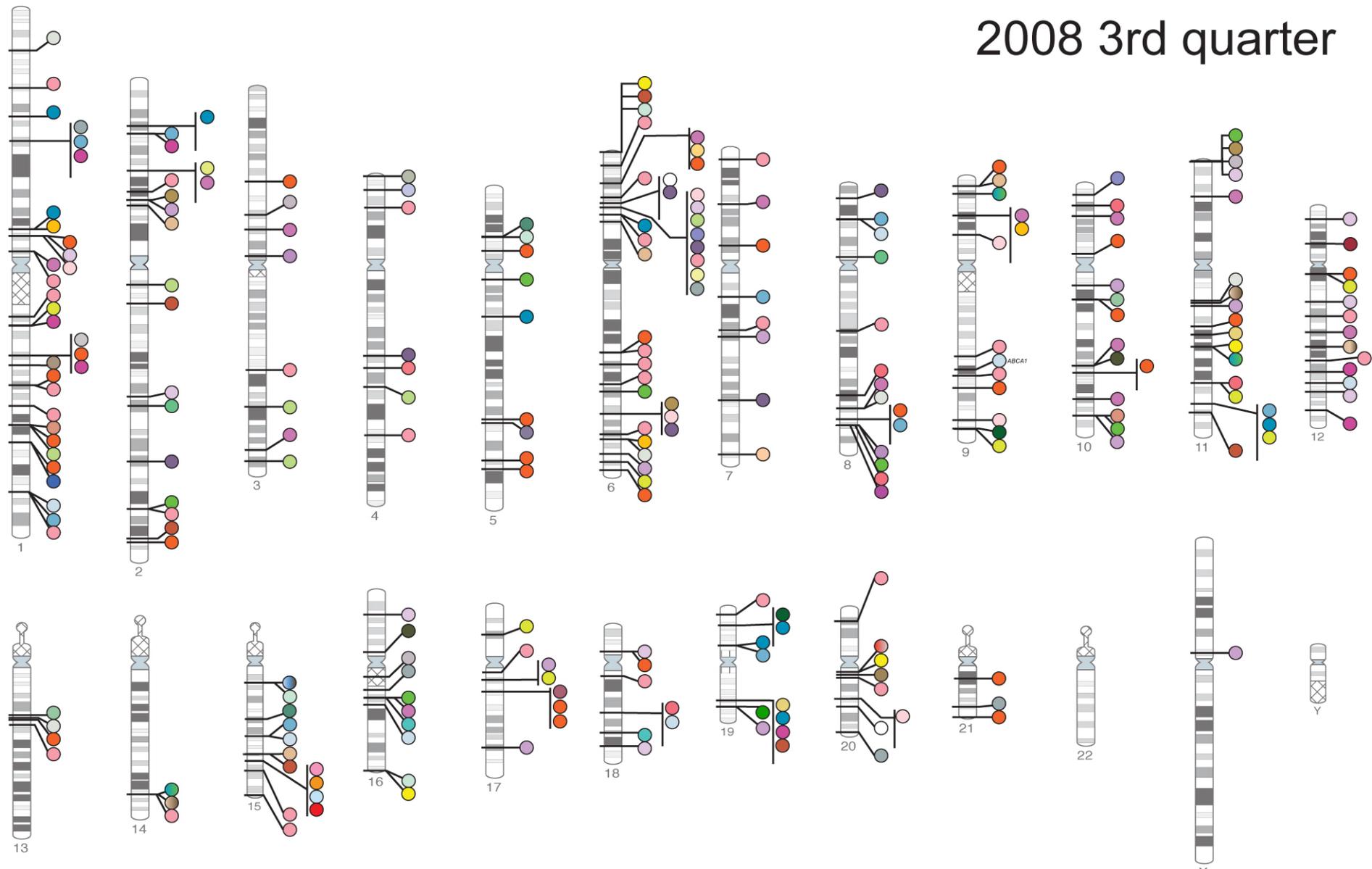
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2008 2nd quarter



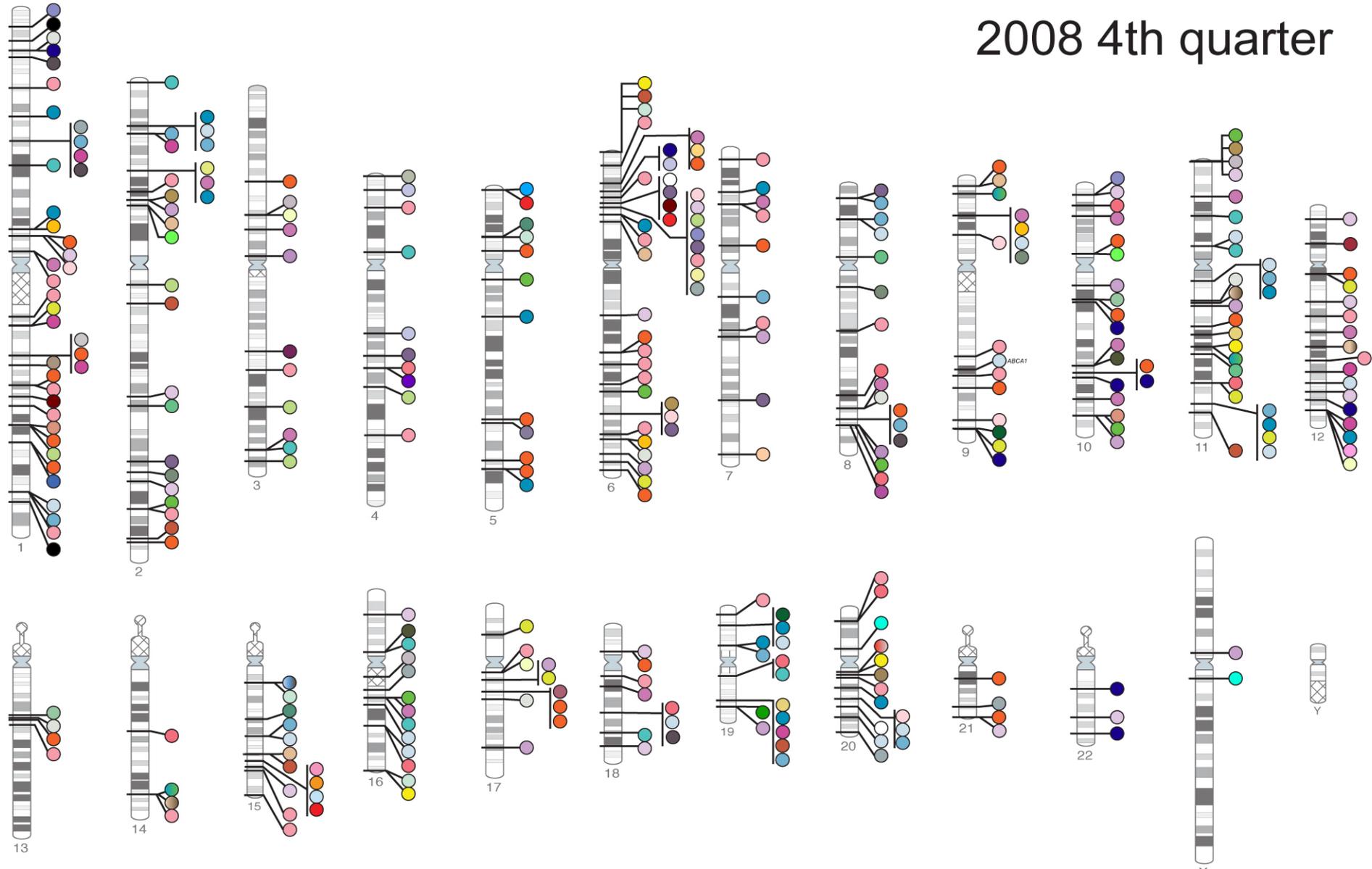
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2008 3rd quarter



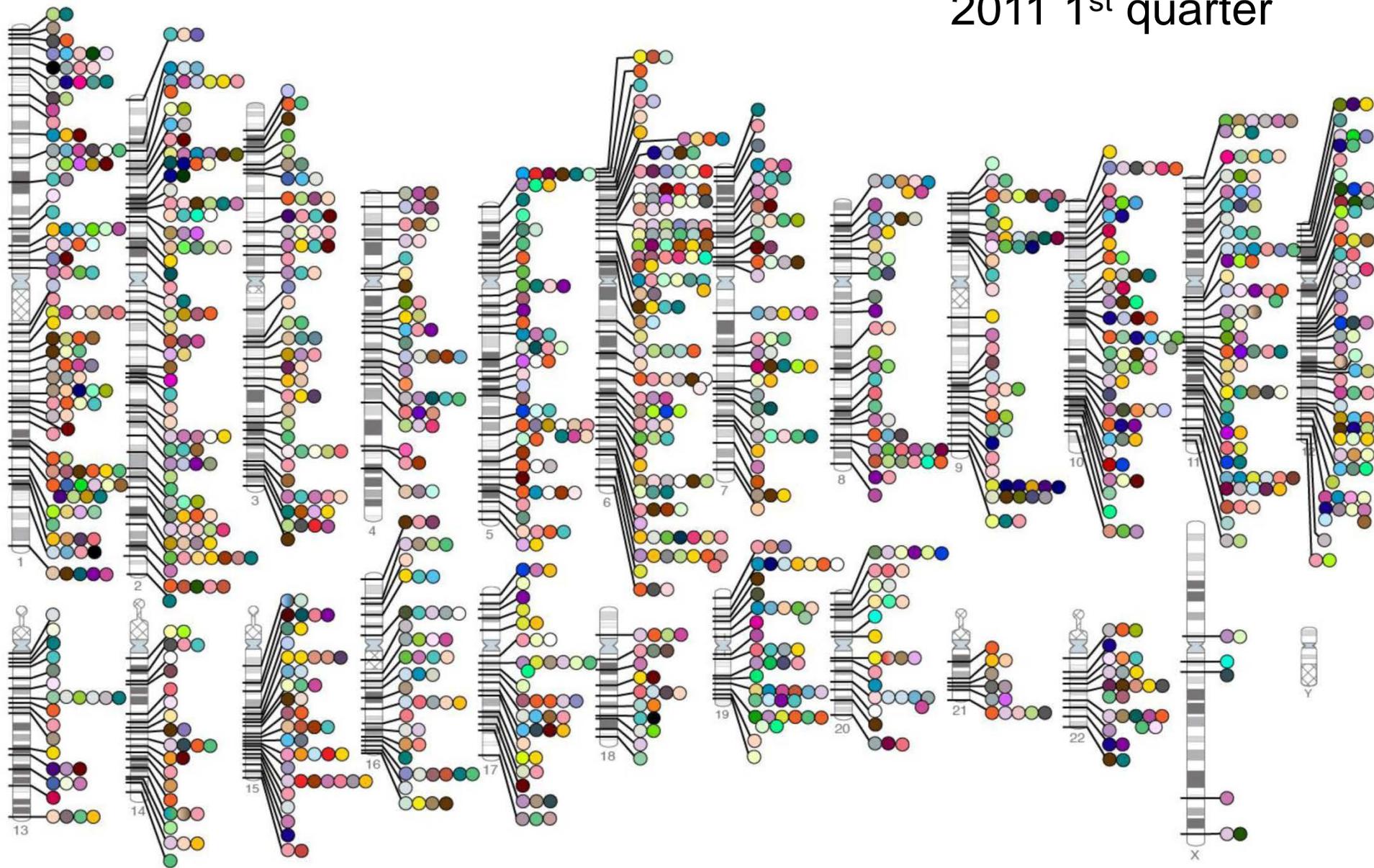
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| ● Alzheimer disease APOE*ε4 carriers | ● Blue or green eyes | ● Colorectal cancer | ● Hair color | ● Juvenile idiopathic arthritis | ● Multiple sclerosis | ● QT interval prolongation | ● Serum metabolites | ● Triglycerides |
| ● Amyotrophic lateral sclerosis | ● BMI, waist circumference | ● Coronary disease | ● Height | ● LDL cholesterol | ● Neuroblastoma | ● Psoriasis | ● Serum urate | ● Type 1 diabetes |
| ● Asthma | ● Bone density | ● Crohn's disease | ● HDL cholesterol | ● Liver enzymes | ● Nicotine dependence | ● Recombination rate | ● Skin pigmentation by reflectance spectroscopy | ● Type 2 diabetes |
| ● Atrial fibrillation | ● Breast cancer | ● Exfoliation glaucoma | ● Idiopathic pulmonary fibrosis | ● Lung cancer | ● Obesity | ● Red vs. non-red hair | ● Soluble ICAM-1 | ● Vitamin B12 levels |
| ● Basal cell cancer | ● C-reactive protein | ● F cell distribution | ● Inflammatory bowel disease | ● Male pattern baldness | ● Other metabolic traits | ● Restless legs syndrome | ● Statin-induced myopathy | ● Warfarin dose |
| ● Bipolar disorder | ● Celiac disease | ● Fasting glucose | ● Intracranial aneurysm | ● MCP-1 | ● Peripheral arterial disease | ● Rheumatoid arthritis | ● Systemic lupus erythematosus | ● Weight |
| ● Bladder cancer | ● Freckles and burning | ● Iris color | ● Mean platelet volume | ● Prostate cancer | ● Prostate cancer | ● Serum IgE levels | ● Systemic lupus erythematosus in women | ● YKL-40 levels |

2008 4th quarter

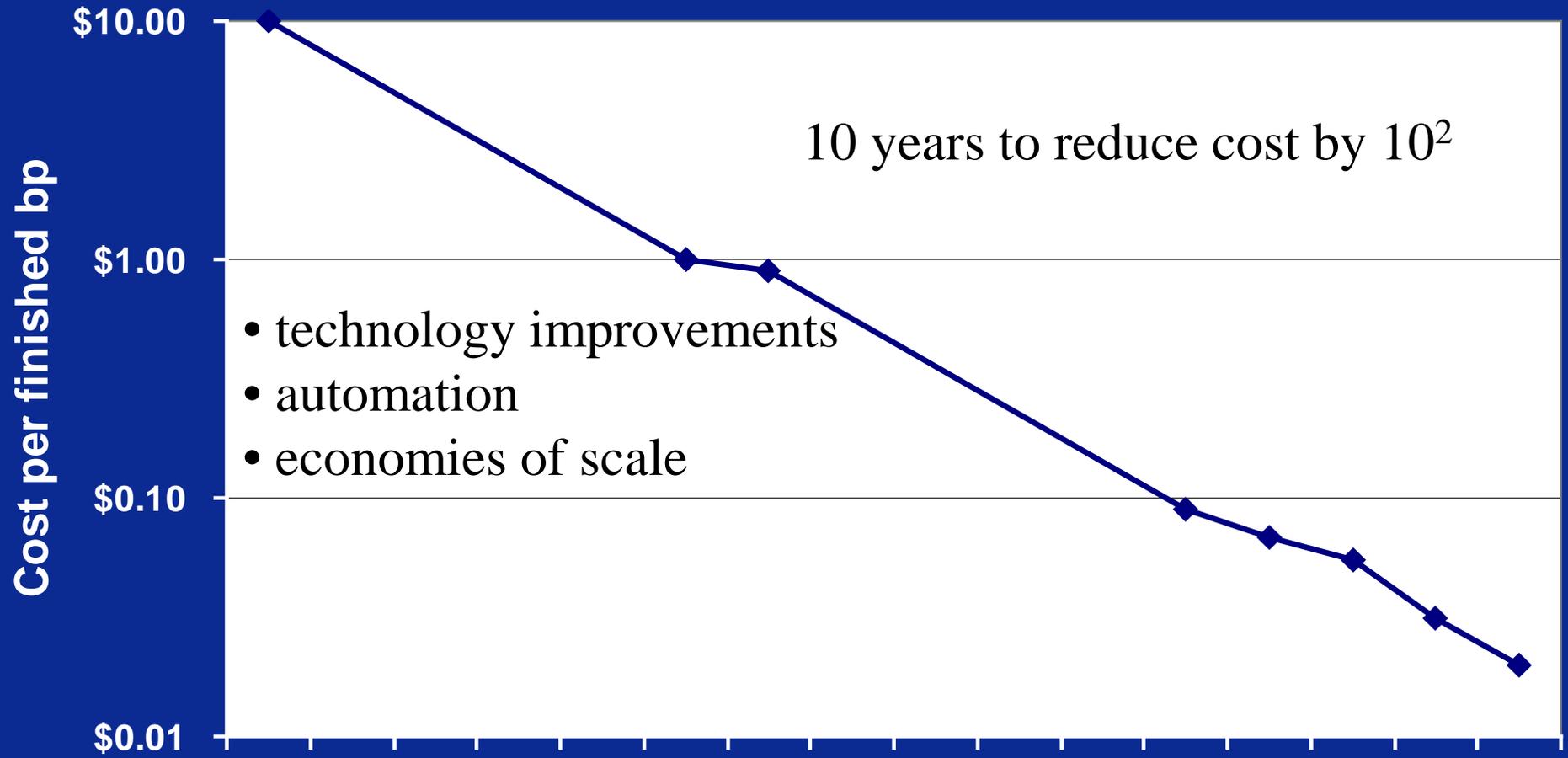


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| ● Asthma | ● Bone density | ● Crohn's disease | ● HDL cholesterol | ● Liver enzymes | ● Nicotine dependence | ● Recombination rate | ● Skin pigmentation by reflectance spectroscopy | ● Type 2 diabetes |
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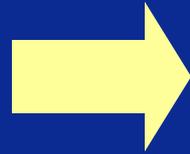
2011 1st quarter



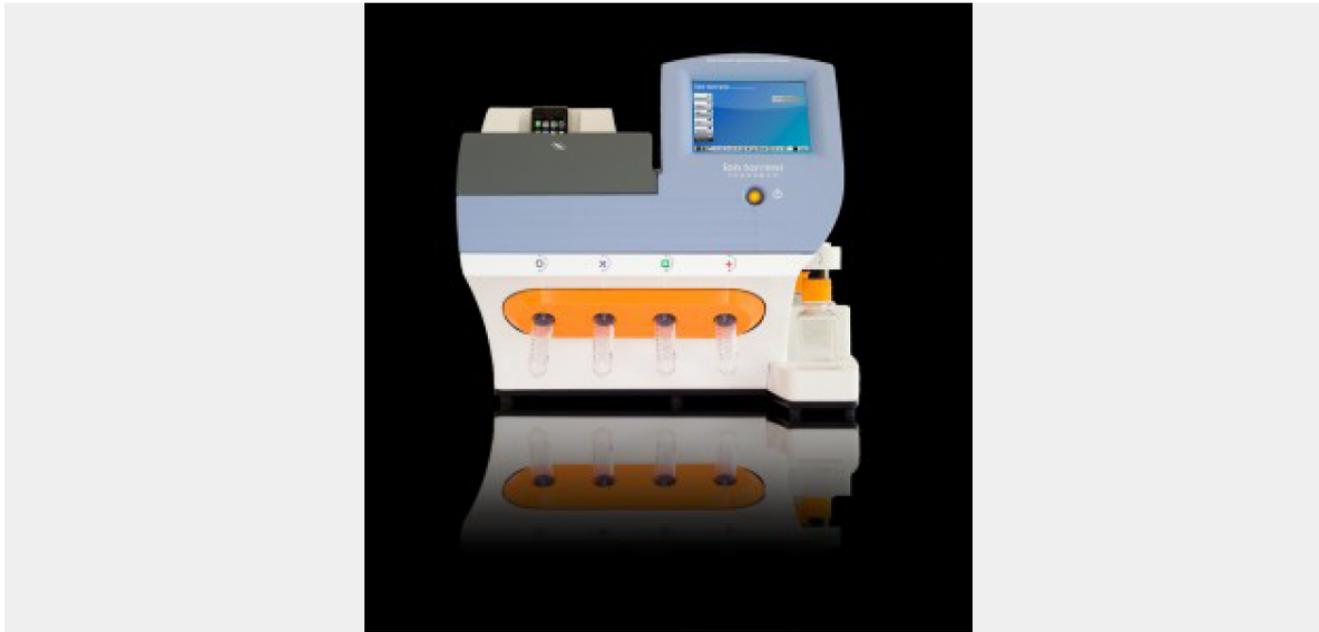
Decrease in the Cost of Finished DNA Sequencing



Technology



Next Generation Sequencing



Life Technologies' Personal Genome Machine

That means that the PGM will be able to sequence 1 billion letters of DNA code in two hours, making it much more competitive with a rival machine, the MiSeq, developed by Illumina, which now dominates the sequencing business.

NATURE | NEWS

Nanopore genome sequencer makes its debut

Technique promises it will produce a human genome in 15 minutes.

Erika Check Hayden

17 February 2012

Technology that its parent company says will sequence a human genome in just 15 minutes opened its first data run to scrutiny today.

Oxford Nanopore Technologies, based in Oxford, UK, revealed the initial results from its GridION system at the Advances in Genome Biology and Technology meeting in Marco Island, Florida. The firm expects to start selling its new machine in the second half of this year and also plans to launch the world's first miniaturized, disposable sequencer — the MinION — which will retail for less than US\$900.

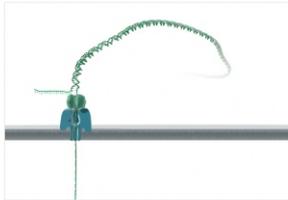
Given its flexibility, scalability and low entry price, "this technology could have a seriously disruptive effect on the sequencing industry," says Daniel MacArthur, a geneticist who [blogs about the genomics industry](#).

That industry is already seeing significant jockeying for position with Swiss drug giant Roche last month launching a takeover bid for the manufacturer of the sector's dominant technology: Illumina of San Diego, California (see [Roche takeover bid poses challenge to Illumina](#)). In the same month, up-and-coming company Ion Torrent Systems of Guilford, Connecticut, vowed to begin selling a machine by the end of the year that can sequence an entire human genome in a day for less than \$1,000 per sequence. And last April, Pacific Biosciences of Menlo Park, California, launched its own sequencing technology.

Oxford Nanopore's system uses nanopore sequencing to rapidly read DNA sequences. A strand of DNA is fed through a biological pore and the various bases are identified by measuring the difference in their electrical conductivity as they pass through the pore (see [Personal genomes: Standard and pores](#)).

The launch of the nanopore machines marks the end of a decades-long

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Fast track: nanopore sequencing identifies individual bases as a strand of DNA is passed through a pore. IEMEDIA SOLUTIONS

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Internet entrepreneur

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Navigenics does not provide medical advice, diagnosis or treatment. You should consult your doctor if you have questions regarding any medical condition, before starting any new

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Rare Disease

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—Dr. Carles Vilatorino-Guell,
 University of British Columbia

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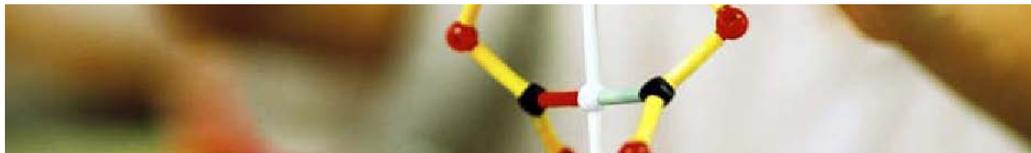
by NANCY SHUTE

01-27 am

Genetic testing for sports genes courts controversy

By Rob Stein, Published: May 18

In an era of helicopter parents eager to exploit every competitive edge for their children, at least two companies have begun selling tests that claim to help match youngsters with the sports they are genetically programmed to play best.



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Should a high school student building a DNA model also have his genetic code tested for disease risks?



DNA Dating: Match-making through genetic testing

August 21, 9:18 AM · Erin Wilson - DC Relationship Psychology Examiner

Ok, We Have Our First DNA-Based Dating Service: GenePartner

Michael Arrington

[29 comments »](#)



Monday, Jun. 29, 2009

Online Dating and Genetics

By Sally McGrane

Remember the famous sweaty-T-shirt experiment? When asked to sniff men's shirts back in 1995, women who were not on the Pill preferred the scent of men who had certain genes that were more dissimilar to their own. Opposites, the data suggested, really do attract. The experiment inspired the launch last summer of [GenePartner.com](#) a Swiss company that uses genetics to predict whether two people will have butterflies in the stomach chemistry. Already, partnerships are in the works with both traditional matchmakers and new online-dating sites, including [Sense2Love.com](#) which plans to add

IdahoStatesman.com

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July 24, 2008

The You Docs: Can a DNA test help you find your soul mate?

Mehmet and Mike are happily married. No, not to each other. To two wonderful ladies (one each, of course). But if they weren't and they lived, say, near Boston, a peculiar dating service might arouse their curiosity. For \$1,995.95, a company called [ScientificMatch.com](#) claims that if you crack open its special kit, rub a cotton swab on the insides of your cheeks and ship the swab to its lab, it will use the DNA it collects to find your soul mate.



Should we be concerned?



Ethical, Legal and Social Implications

- **Fairness in the use of genetic information**
 - Who should have access to genetic information, and how should the information be used?
- **Privacy and confidentiality of genetic information**
 - Who owns and controls genetic information?
- **Psychological impact and stigmatization due to genetic differences**
 - How does personal genetic information affect an individual and society's perception of that individual?
- **Reproductive issues**
 - Are patients properly counseled about the risks and limitations of genetic technology?



Ethical, Legal, and Social Implications

- **Clinical issues**
 - How do we educate health care workers, patients, and the general public about genetic technology capabilities, limitations and applications?
- **Uncertainties associated with gene tests for susceptibilities and complex conditions**
 - Should testing be performed when no treatment is available?
 - Should parents have the right to have their minor children tested for adult onset diseases?
 - Are genetic tests reliable and interpretable by the medical community?
- **Conceptual and philosophical implications regarding human responsibility**
 - Do peoples genes make them behave in a particular way?
 - Can people always control their behavior?



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CASE STUDY

Can You Be Fired for Your Genes?

The number of complaints about genetic discrimination is on the rise

By ADAM COHEN @adamscohen February 20, 2012 11

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In 2010, Pamela Fink, an employee of a Connecticut energy company, made a new kind of discrimination claim: she charged that she had been fired because she carries genes that predispose her to cancer. Fink quickly became the public face for the cutting edge of civil rights: genetic discrimination.



DOUGLAS HEALEY / AP
Pamela Fink at her home in Fairfield, Conn., on April 28, 2010. Fink says she was fired after she tested positive for a breast-cancer gene and had a double mastectomy as a preventative measure

The Genetic Information Nondiscrimination Act, which was passed out of concern for just such cases in the wake of huge advances in genetics testing, took effect in late 2009. GINA, as it is known, makes it illegal for employers to fire or refuse to hire workers based on their "genetic information" — including genetic tests and family history of disease. GINA doesn't just apply to employers: health-insurance companies can be sued for using genetic information to set rates or even just for investigating people's genes.

Cohen is the author of *Nothing to Fear: FDR's Inner Circle and the Hundred Days that*

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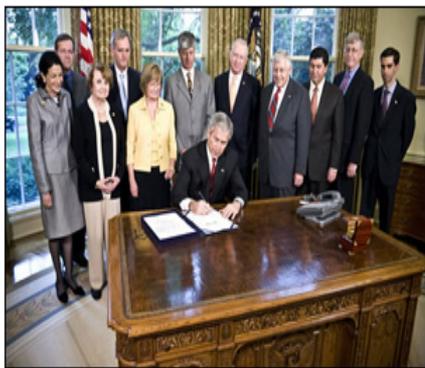
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Genetic Information Nondiscrimination Act: 2007-2008

[Request for Information Regarding Sections 101 Through 104 of the Genetic Information Nondiscrimination Act of 2008](#)

The Department of Labor, one of the federal agencies involved with drafting regulations for implementation of GINA, has issued a Request for Information regarding issues under Sections 101-104 of GINA. **The agency will be accepting public comments until December 9, 2008.**

President Bush Signs Genetic Information Nondiscrimination Act of 2008



President George W. Bush signs H.R. 493, the Genetic Information Nondiscrimination Act of 2008, Wednesday, May 21, 2008, in the Oval Office. White House photo by Eric Draper.

Washington, Wed., May 21 2008 — The President has signed into law the Genetic Information Nondiscrimination Act (GINA) that will protect Americans against discrimination based on their genetic information when it comes to health insurance and employment. The bill had passed the Senate unanimously and the House by a vote of 414 to 1. The long-awaited measure, which has been debated in Congress for 13 years, will pave the way for people to take full advantage of the promise of personalized medicine without fear of discrimination.

Read more: [President Bush Signs H.R. 493, the Genetic Information Nondiscrimination Act of 2008](#) [whitehouse.gov]

The history of GINA's passage through the legislative process, 2007-2008, can be tracked on this page.

2007

Legislative Chronology



The Future




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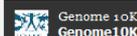
To understand how complex animal life evolved through changes in DNA and use this knowledge to become better stewards of the planet.

The Genome 10K project aims to assemble a genomic zoo—a collection of DNA sequences representing the genomes of 10,000 vertebrate species, approximately one for every vertebrate genus. The trajectory of cost reduction in DNA sequencing suggests that this project will be feasible within a few years. Capturing the genetic diversity of vertebrate species would create an unprecedented resource for the life sciences and for worldwide conservation efforts.

The growing Genome 10K Community of Scientists (G10KCOS), made up of leading scientists representing major zoos, museums, research centers, and universities around the world, is dedicated to coordinating efforts in tissue specimen collection that will lay the groundwork for a large-scale sequencing and analysis project.

Accomplishments

- ▶ Inspired partly by the Genome 10K project, the [iSK initiative](#) to sequence 5,000 insect genomes began in March 2011.
- ▶ G10K announces the first [101 species](#) for sequencing. These add to [120 vertebrate species](#) already being sequenced in public-sector genome projects. See them in [phylogenetic trees](#).
- ▶ The [Genome 10K database](#) catalogs specimens from more than 16,000 vertebrate species, including living and recently extinct mammals, birds, non-avian reptiles, amphibians, and fishes, many of which are threatened or endangered.
- ▶ Inaugural publication in the [Journal of Heredity](#), November 4, 2009—the second most-downloaded article in JOH's history.


 Genome 10K
Genome10K

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Oliver A. Ryder
Director of Genetics, Kleberg Chair, San Diego Zoo Institute for Conservation Research; Adjunct Professor, Division of Biology, UC San Diego

The Alignathon

[Announcing the Alignathon, a](#)


Photo Gallery



Clark Photography

The genetic code for canine shapes and sizes may help unravel human disease. Enjoy photos of different dog breeds in this Robert Clark gallery.

Mix, Match, Morph

Published: February 2012



How to Build a Dog

Scientists have found the secret recipe behind the spectacular variety of dog shapes and sizes, and it could help unravel the complexity of human genetic disease.

By Evan Ratliff

Photograph by Robert Clark

Sidebar



The Forever Dog

Author Evan Ratliff examines the evolutionary history of dogs and their connections to villages in Africa.

It's an unusually balmy mid-February afternoon in New York City, but

S. BAUER/USDA



The honeybee is under threat from a formidable array of pathogens, including the Varroa mite seen here.

APIOLOGY

Geneticists bid to build a better bee

Honeybee genome offers clues for fighting diseases.

BY GWYNETH DICKEY ZAKAIB

says Cornman. “Then we can start looking at

Hemisphere began to show alarming declines. A syndrome dubbed colony collapse disorder (CCD) has been causing the insects to die off in large numbers, leaving well-provisioned hives suddenly empty. Meanwhile, other parasites, such as the Varroa mite (*Varroa destructor*), which spreads harmful viruses, continue to take their toll. Annual surveys in the United States show that almost 35% of all colonies die during a typical winter. Genomics is yielding new clues to the still-mysterious phenomenon, as well as potential strategies for protecting the insects from a multitude of threats.

At the meeting, Cornman presented data showing that hives affected by CCD have higher levels of microscopic gut fungi called *Nosema*, and a greater prevalence of several viruses, two of which had not been detected in bees before.

Yet despite having a multitude of enemies, many bees are holding their own, says research entomologist Jay Evans of the USDA’s bee laboratory. “The question is not why are bees getting sick, but how are they surviving against this onslaught of parasites,” he says.

The genome offers a window into the bees’ immune pathways, Evans adds. The goal is to identify the genes that are crucial in helping bees thwart attack, and, ultimately, to strengthen these defences. “You can breed for these traits, but with genetic markers you could do it faster,” he says.

In cases in which nature cannot do the job, some researchers are now exploring more direct ways of boosting bees’ resilience. In





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Frozen mummy's genetic blueprint unveiled

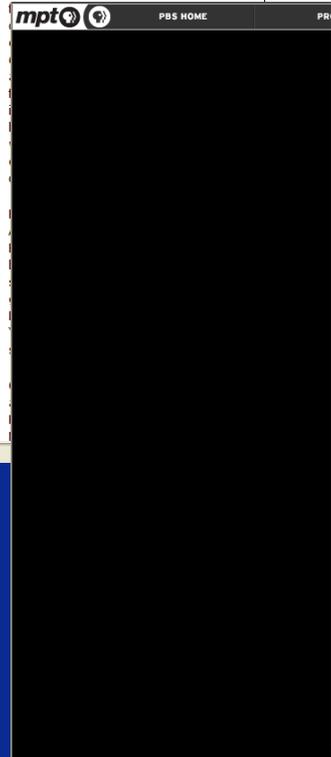
The 5,300-year-old Iceman had brown eyes, Lyr modern-day Mediterranean relatives

By [Tina Hesman Saey](#)
Web edition : Tuesday, February 28th, 2012

By peering deeply into the DNA of the mummy known as Ötzi, geneticists have expanded the rap sheet on the 5,300-year-old Iceman: He had brown eyes, brown hair and blood type O, was lactose intolerant and his modern-day relatives live on Corsica and Sardinia.



These vital statistics and more come



TIME Science

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Study: Malaria, Not Murder, Killed King Tut

By [MICHAEL D. LEMONICK](#) Tuesday, Feb. 16, 2010

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Researchers sample DNA of royal mummies, including that of King Tut, in the Valley of the Kings, on the West Bank of Luxor, Egypt
 Barry Iverson / Discovery Channel

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Carsten Pusch, a medical geneticist with a special interest in ancient diseases, never imagined he'd be called in to help autopsy one of history's oldest and most internationally celebrated corpses. But that's just what happened when Zahi Hawass, the legendary director of Egypt's Supreme Council of Antiquities, rang him up at his offices in the University of Tübingen in Germany.

Would Pusch be interested, asked Hawass, in doing a DNA analysis on several mummies from the 18th Dynasty — including a king who died before he reached the age of 20 and who went by the name of Tutankhamun?

Sequencing Entering the ancient world: Paleogenomics is on the rise

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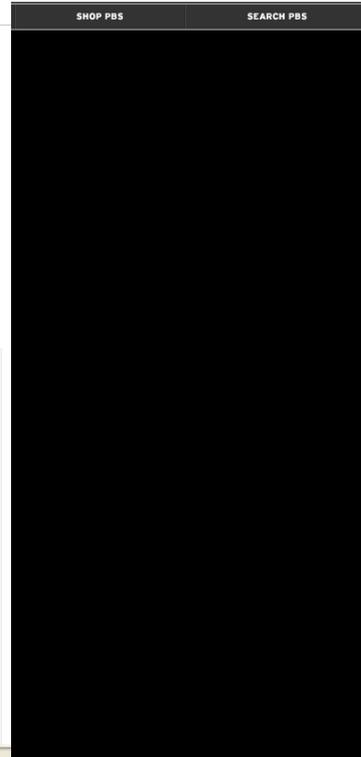
As sequencing technologies emerge on the scene, scientists believe they will be used for projects other than genomics. This notion was reinforced in late 2009 when scientists announced the first genome of a woolly mammoth, which became extinct tens of thousands of years ago. The project could signal the start of a new era in the nascent field of paleogenomics, the study of interest of being able to go back in time and recover potentially fairly

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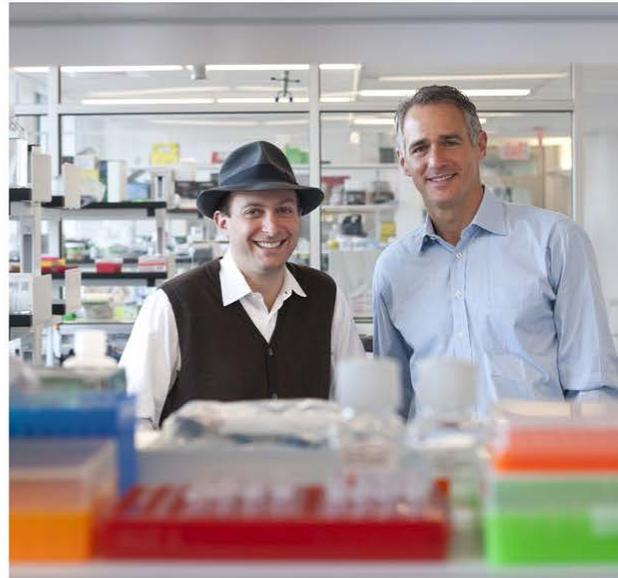
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MAGAZINE: FEATURE

Foundation Medicine: Personalizing Cancer Drugs

Foundation Medicine is offering a test that helps oncologists choose drugs targeted to the genetic profile of a patient's tumor cells. Has personalized cancer treatment finally arrived?

MARCH/APRIL 2012 | BY ADRIENNE BURKE



Michael Pellini fires up his computer and Alexis Borisy (left) and Michael

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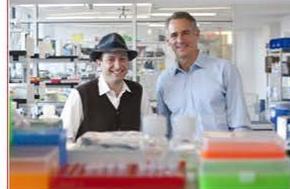
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Foundation Medicine: Personalizing Cancer Drugs

Foundation Medicine is offering a test that helps oncologists choose drugs targeted to the genetic profile of a patient's tumor cells. Has personalized cancer treatment finally arrived?

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Gene therapy 'gave me sight back'

By Helen Briggs
Health editor, BBC News website

Three US citizens who lost their sight in childhood have reported a dramatic improvement in vision after having gene therapy in both eyes.

There was some improvement after the genetic fault in one eye was corrected four years ago.

Now, one woman has described her joy at seeing her children's faces, after her second eye was treated.



Tami Morehouse: 'It's just incredible to see'

The research increases hopes that gene therapy can be used in a range of eye conditions, said a UK expert.

The three have Leber's Congenital Amaurosis (LCA), a rare inherited disease caused by defects in a gene encoding a protein needed for vision.

It appears at birth or in the first months of life, leading to severely impaired vision, involuntary eye movements and poor night vision.

The disorder, which can be caused by 'mistakes' in more than 10 different genes, prevents normal function of the retina; the light-sensitive layer of cells at the back of the eye.

Several teams around the world are carrying out early trials of gene therapy in blindness, including experts at the Philadelphia Children's Hospital and the University of Pennsylvania, US.

Only a handful of patients worldwide have received the treatment to boost a faulty gene underlying an inherited form of blindness.

The US researchers revealed in 2008 that 12 people with LCA had recovered some vision after being injected in one eye with an engineered virus carrying the gene RPE65.

In a follow-up study they treated the other eye of three of them, and found it improved their sight even more.

The subjects could see better in dim light and two were able to find their way around obstacles.

The results were revealed in the latest edition of the journal **Science Translational Medicine**.

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Tami Morehouse on regaining her sight

"Life's just so much easier at a level that most people take for granted. Yes, seeing my kids' faces - my son has big huge black eyes, my daughter has big beautiful blue eyes, and I have to look very carefully to see them, but I can. Everyday things were lost to me and now I have a bit of that back and I just can't tell you what that means."

Tami Morehouse on getting her sight back

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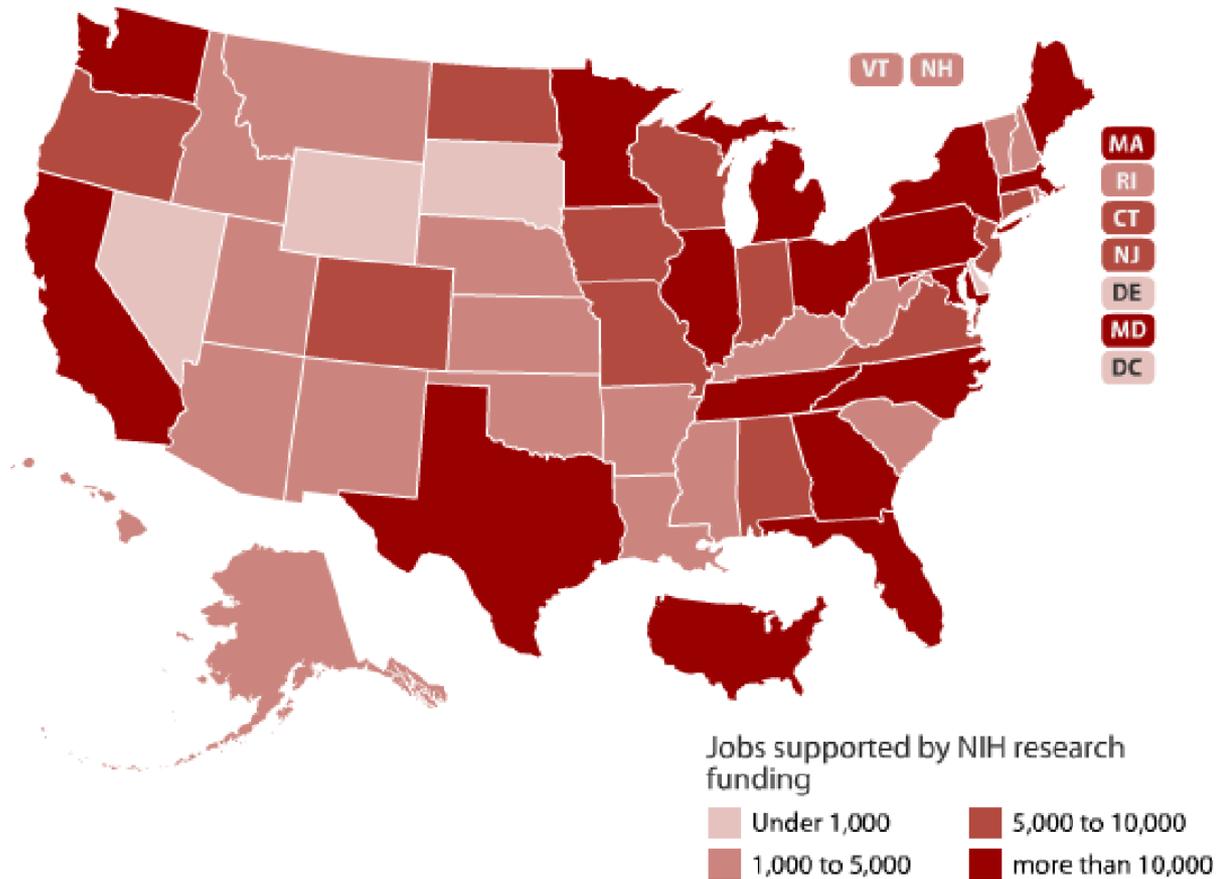
Input The amount of information entering the system outstrips the analytical capacity of drug researchers.

Every now and then, a headline says it all. An article last fall in *Genome Medicine*, for example, carried this one: “The \$1,000 genome, the \$100,000 analysis?” (DOI: 10.1186/gm205). Suppliers and users of genome sequencing and informatics systems agree that the author, Elaine Mardis, perfectly captured the dilemma in genomics-based drug research. In fact, some say Mardis, director of technology development at the [Genome Institute at Washington University](#) in St. Louis, is lowballing the cost of analyzing genomics data.



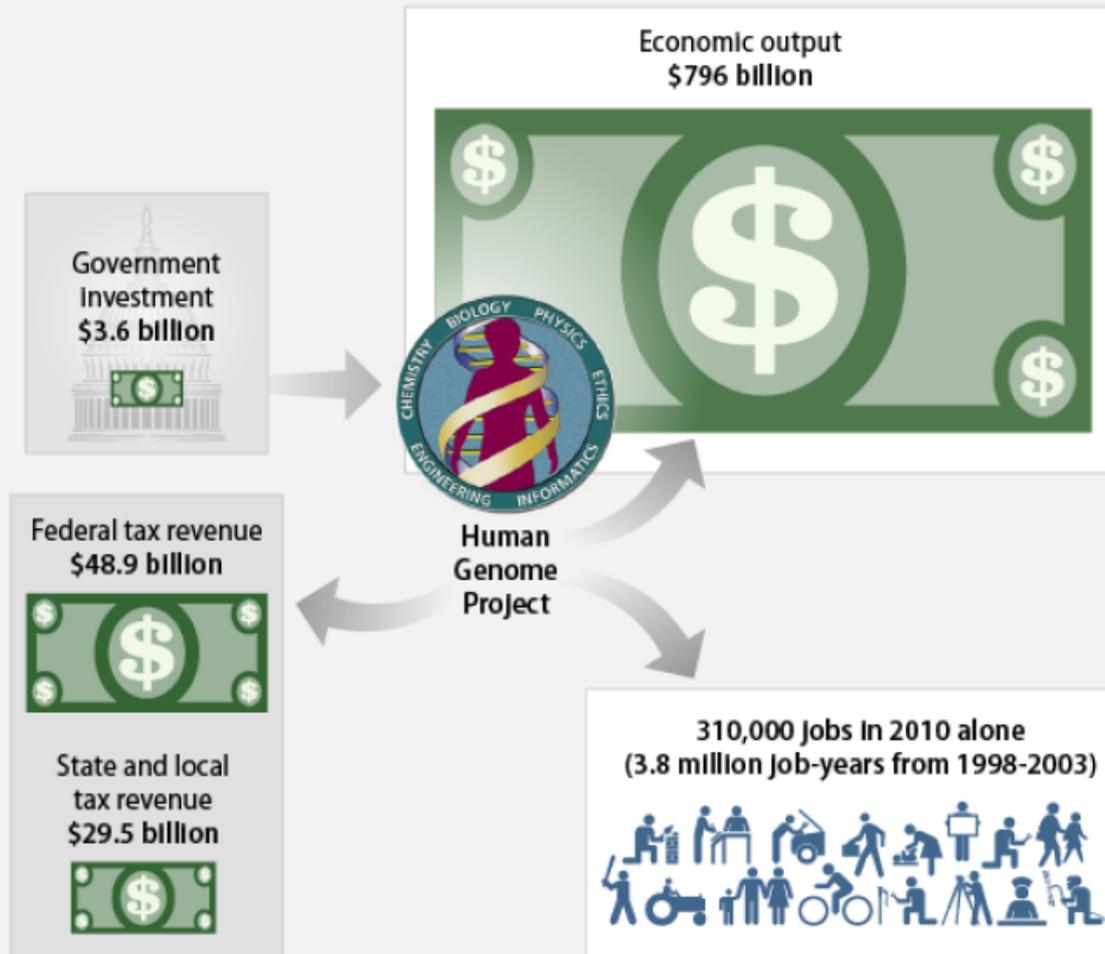
NIH research awards and job creation in every state

Roll over a state to see how many jobs NIH research awards supported in 2010.



Economic Impact of the Human Genome Project, 1988-2003

The Human Genome Project yielded a 14,000% return on investment over the 23 years of its life in terms of economic output and a 1,250% return on investment in terms of federal tax revenue alone



Source: Science Progress with data from "Economic Impact of the Human genome Project," Battelle Technology Partnership Practice, May 2011.



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Genetic Jobs

New Study on the Genetic Testing Industry Shows How Public Research Created Over 100,000 Jobs



SOURCE: AP/Douglas C. Pizac

Vickie Chaplin loads patient samples into a machine for testing at Myriad Genetics in Salt Lake City. A new report shows the rapidly expanding genetic and genomic clinical laboratory testing industry in the United States currently supports 116,000 jobs and \$16.5 billion in national economic output.

By Jason Thomas | February 7, 2012

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This article was originally published on [Science Progress](#)

The era of medical genetic testing is upon us. At least that's the impression one would get after reading this [new Battelle report](#) commissioned by The American Clinical Laboratory Association. The ACLA report shows the rapidly expanding genetic and genomic clinical laboratory testing industry in the United States currently supports 116,000 jobs and \$16.5 billion in national economic output.

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NHGRI

The screenshot shows a web browser window displaying the NHGRI Genomic Careers website. The browser's address bar shows "genome.gov | Genomic Careers: Find Your Future! (St...". The website header includes the NHGRI logo, the text "National Human Genome Research Institute genome.gov", and the tagline "Discover YOUR future in the world of Genomics". A navigation menu contains links for Home, Orientation, Interactive Videos, Career Profiles, Genomics Challenge, Resources, and Career Tracker. The main content area features a large video player with the text "genomiccareers FIND YOUR FUTURE" and a play button. To the right of the video player are three interactive sections: "Career Tracker" with a "Rate Your Favorites" section (3 stars), "Explore" with "Interactive Videos", and "Play" with "The Genomics Challenge". At the bottom of the page, there are links for Privacy, Copyright, Contact, Accessibility, Site Map, Staff Directory, and FOIA, along with logos for the Department of Health & Human Services, the National Institutes of Health, and USA.gov.

www.genome.gov/GenomicCareers



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